



US009448245B2

(12) **United States Patent**
Takano et al.

(10) **Patent No.:** **US 9,448,245 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

(54) **SPECIMEN TRANSPORTATION SYSTEM**

(56) **References Cited**

(71) Applicant: **HITACHI ALOKA MEDICAL, LTD.**,
Mitaka-shi, Tokyo (JP)

U.S. PATENT DOCUMENTS

(72) Inventors: **Dai Takano**, Mitaka (JP); **Katsuhiro Suzuki**, Mitaka (JP)

4,360,216 A * 11/1982 Wiemers A01B 59/042
172/272
6,594,535 B1 * 7/2003 Costanza G05B 19/41865
700/97

(73) Assignee: **HITACHI ALOKA MEDICAL, LTD.**,
Tokyo (JP)

(Continued)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

FOREIGN PATENT DOCUMENTS

CN 101526545 A 9/2009
CN 102236025 A 11/2011

(Continued)

(21) Appl. No.: **14/411,953**

(22) PCT Filed: **Sep. 24, 2013**

OTHER PUBLICATIONS

(86) PCT No.: **PCT/JP2013/075725**

Office Action dated Sep. 30, 2015, issued in counterpart Chinese
Application No. 201380048128.9 with English translation. (5
pages).

§ 371 (c)(1),

(2) Date: **Dec. 30, 2014**

(Continued)

(87) PCT Pub. No.: **WO2014/050822**

PCT Pub. Date: **Apr. 3, 2014**

Primary Examiner — Douglas Hess

(65) **Prior Publication Data**

US 2015/0323556 A1 Nov. 12, 2015

(74) Attorney, Agent, or Firm — Westerman, Hattori,
Daniels & Adrian, LLP

(30) **Foreign Application Priority Data**

Sep. 26, 2012 (JP) 2012-213100

(57) **ABSTRACT**

(51) **Int. Cl.**

G01N 35/04 (2006.01)

G01N 35/02 (2006.01)

(Continued)

A specimen transportation system is configured from linear modules, turn modules, and connection modules, wherein adjacent modules are connected to one another, and the modules form multiple paths through which specimen racks outputted from one specimen output device are transported to multiple analysis devices. Each path is associated with a node signal indicating whether said path can be used for transportation, and a node signal sequence comprising multiple node signals of the paths is configured. In the specimen transportation system, the node signal sequence is transferred from the downstream side to the upstream side, and problems such as the detention of a specimen rank in the specimen transportation system are dealt with by using said node signal sequence.

(52) **U.S. Cl.**

CPC **G01N 35/00871** (2013.01); **B65G 21/06**
(2013.01); **B65G 43/00** (2013.01);

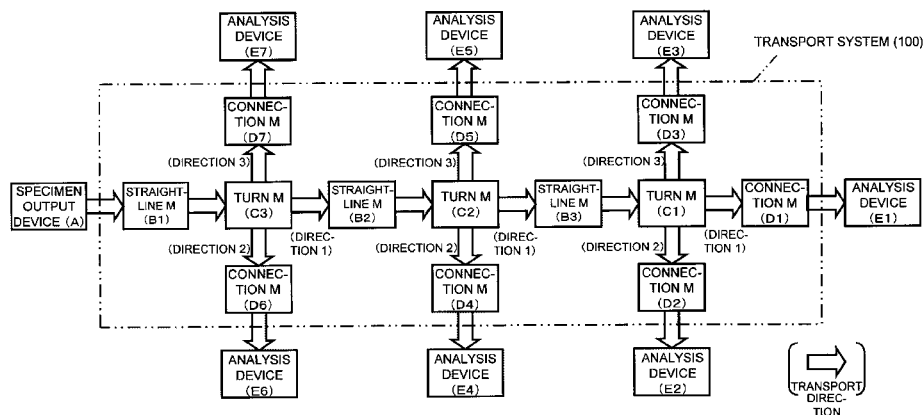
(Continued)

(58) **Field of Classification Search**

CPC **G01N 35/02**; **G01N 35/04**
USPC 700/213, 223, 226, 228, 230; 198/340,
198/340.1, 437

See application file for complete search history.

15 Claims, 9 Drawing Sheets



- (51) **Int. Cl.**
G01N 35/00 (2006.01)
B65G 21/06 (2006.01)
B65G 43/00 (2006.01)
- 2004/0253149 A1 12/2004 Furino et al.
2009/0223308 A1 9/2009 Fukuma
2011/0244582 A1 10/2011 Tatsutani
2012/0004766 A1 1/2012 Stoll et al.

- (52) **U.S. Cl.**
CPC ... **G01N 35/04** (2013.01); **G01N 2035/00326**
(2013.01); **G01N 2035/00643** (2013.01); **G01N**
2035/047 (2013.01); **G01N 2035/0412**
(2013.01); **G01N 2035/0462** (2013.01); **G01N**
2035/0465 (2013.01)

FOREIGN PATENT DOCUMENTS

- (56) **References Cited**

U.S. PATENT DOCUMENTS

6,600,418 B2 * 7/2003 Francis G06K 17/00
340/10.1
6,651,110 B1 * 11/2003 Caspers G05B 19/042
710/115
7,120,884 B2 * 10/2006 Reinschmidt G06K 19/067
257/758
7,242,302 B2 * 7/2007 Rai G06Q 10/06
235/376
8,068,978 B2 * 11/2011 D'Andrea G01C 21/005
701/412
8,110,768 B2 * 2/2012 Girnus B07C 3/001
209/584
8,538,692 B2 * 9/2013 Wurman G06Q 10/08
340/988
8,918,202 B2 * 12/2014 Kawano G05D 1/0234
700/213
8,930,133 B2 * 1/2015 Wurman G06Q 10/08
414/334
8,989,889 B2 * 3/2015 Kobayashi H01L 21/67745
700/112
9,031,683 B2 * 5/2015 Elfstrom G06Q 10/06
700/116
9,222,952 B2 * 12/2015 Tatsutani G01N 35/04
2003/0044319 A1 3/2003 Itoh
2004/0096361 A1 5/2004 Matsubara et al.

DE 202012001229 U1 5/2012
GB 2487234 A 7/2012
JP 9-54096 A 2/1997
JP 2000-55924 A 2/2000
JP 2000-88860 A 3/2000
JP 2000-314737 A 11/2000
JP 2001-99844 A 4/2001
JP 2003-98180 A 4/2003
JP 2003-121451 A 4/2003
JP 2004-286748 A 10/2004
JP 2007-315835 A 12/2007
JP 2008-241513 A 10/2008

OTHER PUBLICATIONS

Search Report dated Oct. 14, 2015, issued in counterpart European Application No. 13841352.1-1553/2902789. (10 pages).
Search Report dated Oct. 14, 2015, issued in counterpart European Application No. 13840409.0.-1553/2902788. (8 pages).
Office Action dated Sep. 22, 2015, issued in counterpart Chinese Application No. 2013800481359, with English translation. (14 pages).
Notification Concerning Transmittal of the International Preliminary Report on Patentability (Chapter I and Chapter II) (Form PCT/IP/326) of International Application No. PCT/JP2013/075725 mailed Apr. 9, 2015 with forms PCT/IB/373, PCT/IB/338 and PCT/ISA/237.
International Search Report dated Nov. 12, 2013, issued in corresponding application No. PCT/JP2013/075725.
Office Action dated Feb. 24, 2016, issued in counterpart Chinese Patent Application No. 201380048128.9, with English translation. (18 pages).

* cited by examiner

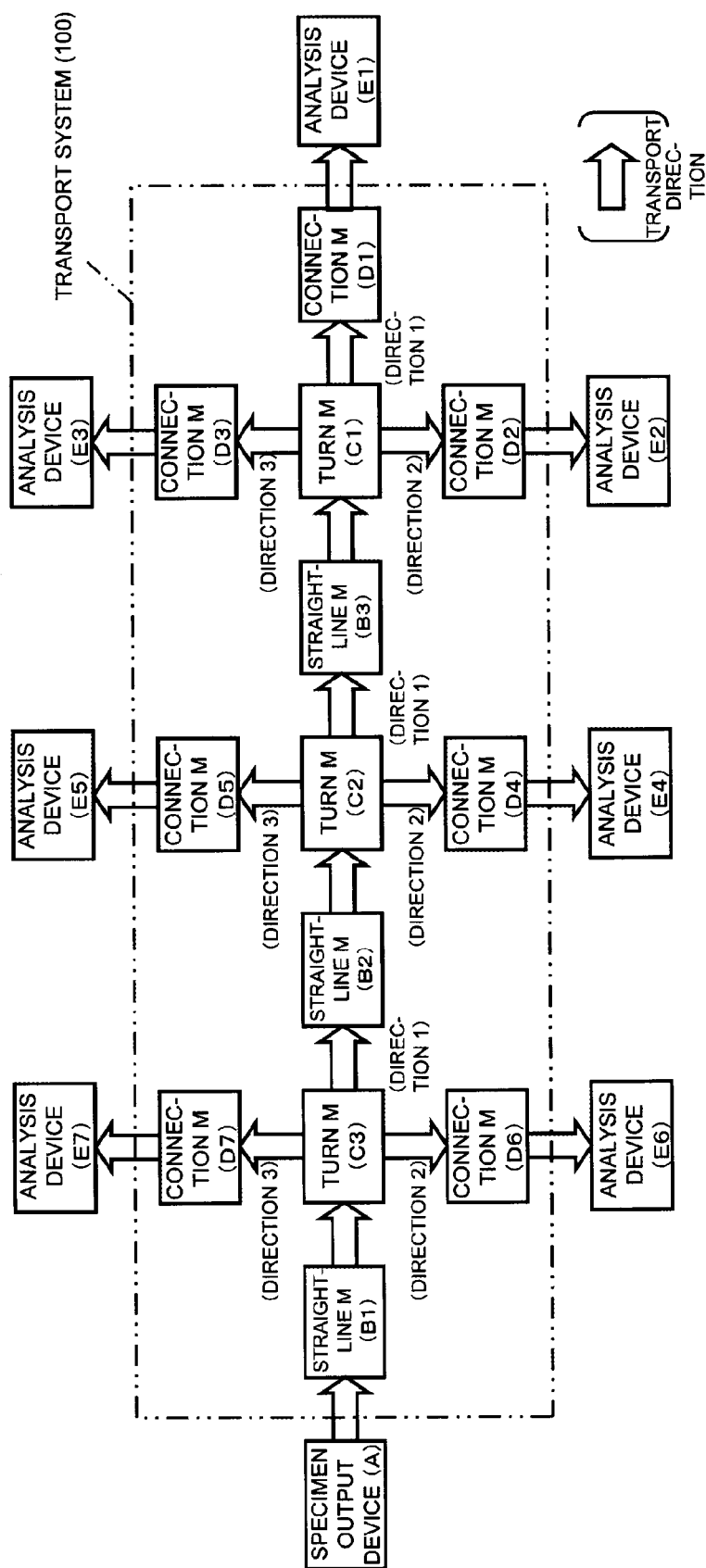


FIG. 1

<FIRST SPECIFIC EXAMPLE OF SETTING AND CONTROL OF TURN MODULE>

ANALYSIS DEVICE (DESTINATION)	DESTINATION CODE SIGNAL			TURN M (C3)				TURN M (C2)				TURN M (C1)			
	bit2	bit1	bit0	DIRECTION SW	bit1	bit0	DIRECTION	DIRECTION SW	bit1	bit0	DIRECTION	DIRECTION SW	bit1	bit0	DIRECTION
E1	L	L	H	SW1	OFF	ON	0 DEGREE	SW1	OFF	ON	0 DEGREE	SW1	OFF	ON	0 DEGREE
E2	L	H	L	SW2	OFF	ON	0 DEGREE	SW2	OFF	ON	0 DEGREE	SW2	ON	OFF	90 DEGREES TO RIGHT
E3	L	H	H	SW3	OFF	ON	0 DEGREE	SW3	OFF	ON	0 DEGREE	SW3	ON	ON	90 DEGREES TO LEFT
E4	H	L	L	SW4	OFF	ON	0 DEGREE	SW4	ON	OFF	90 DEGREES TO RIGHT	SW4	OFF	OFF	(NON-SET)
E5	H	L	H	SW5	OFF	ON	0 DEGREE	SW5	ON	ON	90 DEGREES TO LEFT	SW5	OFF	OFF	(NON-SET)
E6	H	H	L	SW6	ON	OFF	90 DEGREES TO RIGHT	SW6	OFF	OFF	(NON-SET)	SW6	OFF	OFF	(NON-SET)
E7	H	H	H	SW7	ON	ON	90 DEGREES TO LEFT	SW7	OFF	OFF	(NON-SET)	SW7	OFF	OFF	(NON-SET)

FIG. 2

<SECOND SPECIFIC EXAMPLE OF SETTING AND CONTROL OF TURN MODULE>

ANALYSIS DEVICE (DESTINATION)	DESTINATION CODE SIGNAL			DP SW	TURN M (C3)			TURN M (C2)			TURN M (C1)					
	bit2	bit1	bit0		SW1	SW2	SW3	DIRECTION	SW1	SW2	SW3	DIRECTION	SW1	SW2	SW3	DIRECTION
E1	L	L	H	bit1	ON	OFF	OFF	0 DEGREE	ON	OFF	OFF	0 DEGREE	ON	OFF	OFF	0 DEGREE
E2	L	H	L	bit2	ON	OFF	OFF	0 DEGREE	ON	OFF	OFF	0 DEGREE	OFF	ON	OFF	90 DEGREES TO RIGHT
E3	L	H	H	bit3	ON	OFF	OFF	0 DEGREE	ON	OFF	OFF	0 DEGREE	OFF	OFF	ON	90 DEGREES TO LEFT
E4	H	L	L	bit4	ON	OFF	OFF	0 DEGREE	OFF	ON	OFF	90 DEGREES TO RIGHT	OFF	OFF	OFF	(NON-SET)
E5	H	L	H	bit5	ON	OFF	OFF	0 DEGREE	OFF	OFF	ON	90 DEGREES TO LEFT	OFF	OFF	OFF	(NON-SET)
E6	H	H	L	bit6	OFF	ON	OFF	90 DEGREES TO RIGHT	OFF	OFF	OFF	(NON-SET)	OFF	OFF	OFF	(NON-SET)
E7	H	H	H	bit7	OFF	OFF	ON	90 DEGREES TO LEFT	OFF	OFF	OFF	(NON-SET)	OFF	OFF	OFF	(NON-SET)

(IN CASE THAT ANALYSIS DEVICE (E7) HAS FAILED)

OFF

FIG. 3

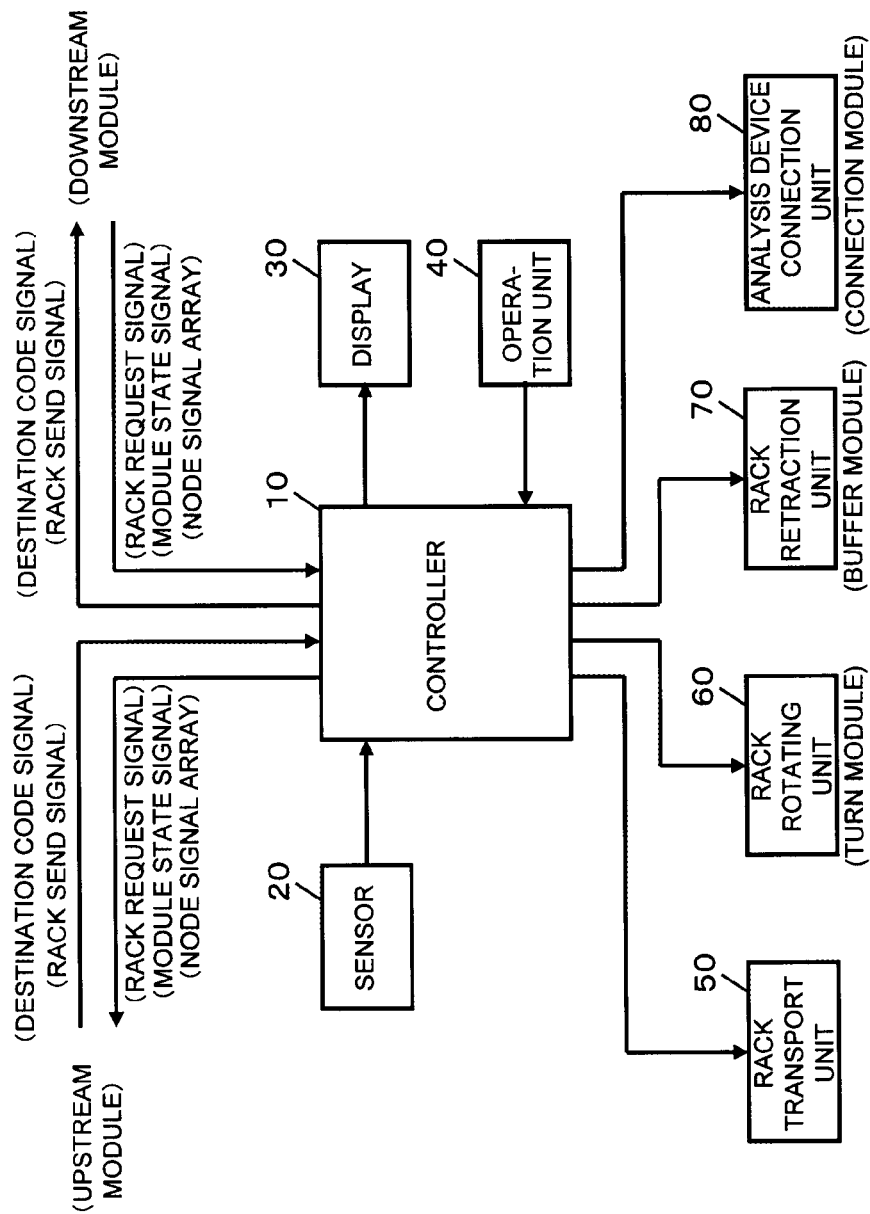


FIG. 4

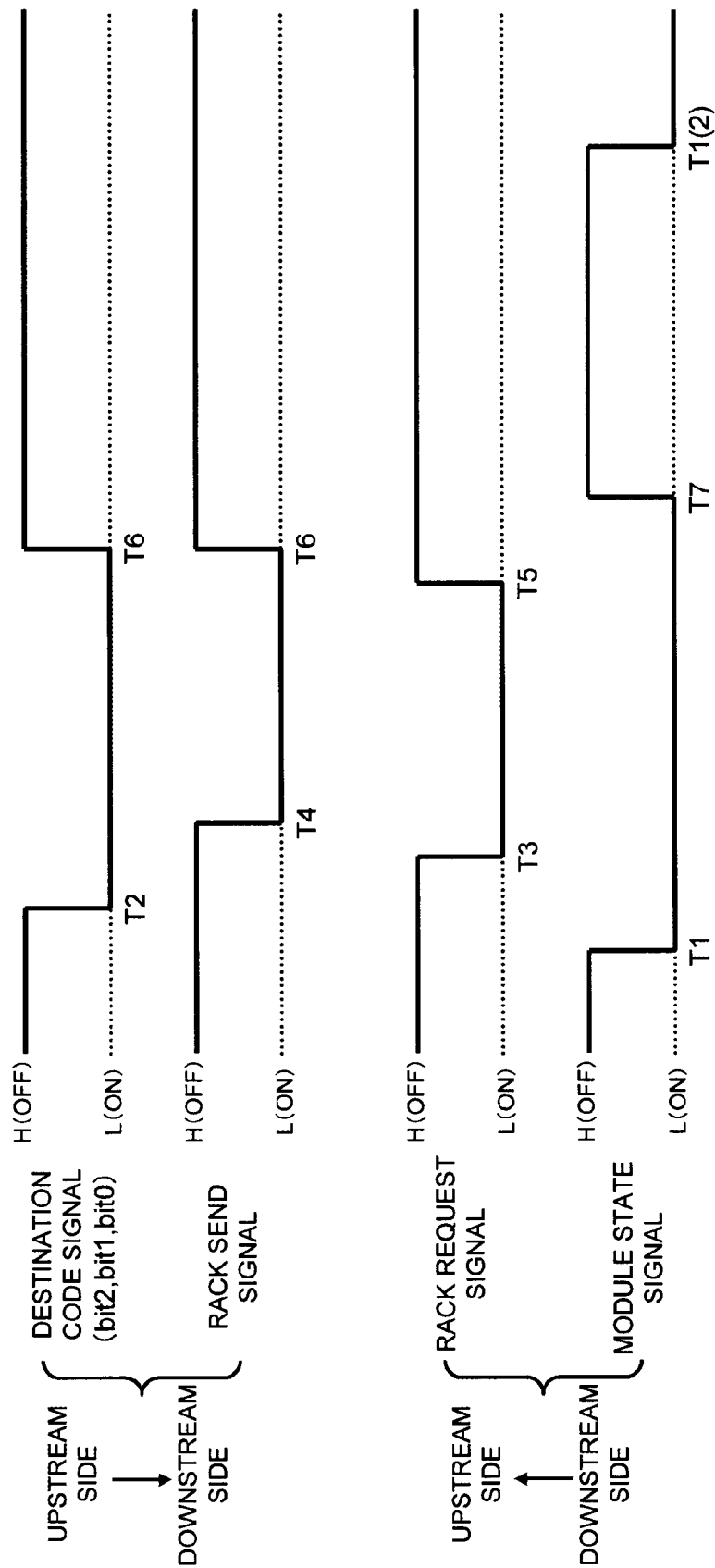


FIG. 5

< TRANSPORT POSSIBLE IN ALL MODULES >

NODE SIGNAL ARRAY	CONNEC- TION M (D1)	CONNEC- TION M (D2)	CONNEC- TION M (D3)	TURN M (C1)	STRAIGHT- LINE M (B3)	CONNEC- TION M (D4)	CONNEC- TION M (D5)	TURN M (C2)	STRAIGHT- LINE M (B2)	CONNEC- TION M (D6)	CONNEC- TION M (D7)	TURN M (C3)	STRAIGHT- LINE M (B1)
NODE1	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
NODE2	OFF	ON	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
NODE3	OFF	OFF	ON	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
NODE4	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON	OFF	OFF	ON	ON
NODE5	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	ON	ON
NODE6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON
NODE7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
NODE8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

FIG. 6

< TRANSPORT POSSIBLE IN ALL MODULES → TRANSPORT IMPOSSIBLE IN CONNECTION M (D3) >

NODE SIGNAL ARRAY	CONNE- TION M (D1)	CONNE- TION M (D2)	CONNE- TION M (D3)	TURN M (C1)	STRAIGHT- LINE M (B3)	CONNE- TION M (D4)	CONNE- TION M (D5)	TURN M (C2)	STRAIGHT- LINE M (B2)	CONNE- TION M (D6)	CONNE- TION M (D7)	TURN M (C3)	STRAIGHT- LINE M (B1)
NODE 1	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
NODE 2	OFF	ON	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
NODE 3	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
NODE 4	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON	OFF	OFF	ON	ON
NODE 5	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	ON	ON
NODE 6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON
NODE 7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
NODE 8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

FIG. 7

< TRANSPORT POSSIBLE IN ALL MODULES → TRANSPORT IMPOSSIBLE IN TURN M (C1) >

NODE SIGNAL ARRAY	CONNEC- TION M (D1)	CONNEC- TION M (D2)	CONNEC- TION M (D3)	TURN M (C1)	STRAIGHT- LINE M (B3)	CONNEC- TION M (D4)	CONNEC- TION M (D5)	TURN M (C2)	STRAIGHT- LINE M (B2)	CONNEC- TION M (D6)	CONNEC- TION M (D7)	TURN M (C3)	STRAIGHT- LINE M (B1)
NODE1	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
NODE2	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
NODE3	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
NODE4	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON	OFF	OFF	ON	ON
NODE5	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	ON	ON
NODE6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON
NODE7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
NODE8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

FIG. 8

< TRANSPORT POSSIBLE IN ALL MODULES → TRANSPORT IMPOSSIBLE IN STRAIGHT-LINE M (B2) >

NODE SIGNAL ARRAY	CONNEC- TION M (D1)	CONNEC- TION M (D2)	CONNEC- TION M (D3)	TURN M (C1)	STRAIGHT- LINE M (B3)	CONNEC- TION M (D4)	CONNEC- TION M (D5)	TURN M (C2)	STRAIGHT- LINE M (B2)	CONNEC- TION M (D6)	CONNEC- TION M (D7)	TURN M (C3)	STRAIGHT- LINE M (B1)
NODE1	ON	OFF	OFF	ON	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF
NODE2	OFF	ON	OFF	ON	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF
NODE3	OFF	OFF	ON	ON	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF
NODE4	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF
NODE5	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	OFF	OFF	OFF	OFF
NODE6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON
NODE7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
NODE8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

FIG. 9

1

SPECIMEN TRANSPORTATION SYSTEM**TECHNICAL FIELD**

The present invention relates to a specimen transport system.

BACKGROUND ART

A specimen transport system is a system that transports a specimen, for example, housed in a specimen rack, and transports the specimen rack housing the specimen obtained from a specimen pre-treatment device or the like to an analysis device for the specimen or the like. A plurality of analysis devices, for example, are connected to the specimen transport system, and the specimen transport system transports the specimen to an analysis device, among the plurality of analysis devices, identified according to the specimen, by suitably controlling, for example, a turn unit or the like which changes a transport path of the specimen (Patent Documents 1 and 2).

In general, in a system such as a specimen transport system, a central control unit that controls and manages the overall system is provided. For example, a central control unit formed by a computer or the like controls a plurality of turn units or the like in the specimen transport system according to the specimen or the specimen rack, to transport the specimen or the specimen rack to an analysis device according to the specimen or the specimen rack.

RELATED ART REFERENCES**Patent Documents**

[Patent Document 1] JP 2007-315835 A

[Patent Document 2] JP 2000-55924 A

DISCLOSURE OF INVENTION**Technical Problem**

In view of the above-described related art, the present inventors have conducted research and development toward a new system structure related to the specimen transport system. In particular, the present inventors have focused attention on a system structure that would significantly reduce the control by the central control unit, and desirably, that does not require the central control unit.

The present invention has been made in the course of the research and the development as described above, and an advantage thereof is in that an improved system structure related to the specimen transport system is realized.

Solution to Problem

According to one aspect of the present invention, there is provided a specimen transport system comprising a plurality of modules, wherein a plurality of paths for transporting a specimen from upstream to downstream are formed by the plurality of modules, for each of the paths, a node signal indicating possibility/impossibility of transport in the path is correlated, and a node signal array made of a plurality of the node signals for the plurality of paths is formed, the plurality of modules include an intermediate module placed partway on each path, and the intermediate module has a function to transport a specimen which has been transported from the upstream side to the downstream side, a function to transmit

2

the node signal array acquired from the downstream side to the upstream side, and a function to change, when the intermediate module becomes unable to transport, a node signal of a path including the intermediate module in the node signal array to be transmitted to transport impossible.

The above-described specimen transport system includes a plurality of modules, and, in a constructed specimen transport system, for example, each module transports a specimen transported from the upstream side to the downstream side. A node signal array is formed by node signals indicating possibility/impossibility of transport on the paths, and the node signal array is transmitted from the downstream side of the path to the upstream side. With the use of the node signal array, it is possible to check, for example, a path in which the transport is possible and a path in which the transport is not possible at a module or a device at the upstream side. Because of this, for example, the possibility/impossibility of the transport in each path can be checked while significantly reducing the control by a central control unit that manages the overall system, or, more desirably, while not requiring the central control unit.

According to another aspect of the present invention, preferably, the plurality of modules can be freely combined with each other, and adjacent modules are connected to each other to form the plurality of paths.

According to another aspect of the present invention, preferably, the plurality of modules include a furthest upstream module placed at the furthest upstream side of each path, and the furthest upstream module has a function to request a specimen to be transported to each path to a device connected at the upstream side.

According to another aspect of the present invention, preferably, the furthest upstream module refers to the node signal array acquired from a downstream module connected at the downstream side, and requests, to the device at the upstream side, a specimen to be transported to a path for which the node signal indicates possibility of transport while avoiding a request of a specimen to be transported to a path for which the node signal indicates impossibility of transport.

According to another aspect of the present invention, preferably, the plurality of modules include a furthest downstream module placed at a lowermost side of each path, and the furthest downstream modules has a function to connect an analysis device of a specimen at the downstream side.

According to another aspect of the present invention, preferably, the furthest downstream module has a function to change, when the analysis device connected at the downstream side cannot accept a specimen, a node signal of a path to the analysis device via the furthest downstream module to transport impossible.

Advantageous Effects of Invention

According to various aspects of the present invention, an improved system structure related to the specimen transport system can be realized. For example, according to preferable configurations of the present invention, with the use of the node signal array formed by node signals indicating possibility/impossibility of transport in the paths, the possibility/impossibility of transport in each path can be checked while significantly reducing control by a central control unit that manages the overall system, or, desirably, while not requiring the central control unit.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a diagram showing an overall structure of a specimen transport system preferable in practicing the present invention.

3

FIG. 2 is a diagram showing a first specific example configuration of setting and control of a turn module.

FIG. 3 is a diagram showing a second specific example configuration of setting and control of a turn module.

FIG. 4 is a diagram showing a structure of each module.

FIG. 5 is a timing chart of signals exchanged between modules.

FIG. 6 is a diagram showing a specific example configuration in which transport is possible in all modules.

FIG. 7 is a diagram showing a specific example configuration in which transport at a connection module is not possible.

FIG. 8 is a diagram showing a specific example configuration in which transport at a turn module is not possible.

FIG. 9 is a diagram showing a specific example configuration in which transport at a straight-line module is not possible.

BEST MODE FOR CARRYING OUT THE INVENTION

FIG. 1 is a diagram showing an overall structure of a specimen transport system 100 preferable in practicing the present invention. The specimen transport system 100 is a system that transports a specimen which is output from a specimen output device A such as a specimen pre-treatment device to a plurality of analysis devices E (E1~E7). The specimen is housed in a container such as, for example, a test tube, one or more containers housing the specimens are housed in a specimen rack, and the specimen transport system 100 transports the specimen rack.

The specimen transport system 100 of FIG. 1 is formed by a plurality of modules. In FIG. 1, a "straight-line M" shows a straight-line module, a "turn M" shows a turn module, and a "connection M" shows a connection module. Thus, in the specific example configuration shown in FIG. 1, the specimen transport system 100 includes straight-line modules B (B1~B3), turn modules C (C1~C3), and connection modules D (D1~D7).

The plurality of modules can be freely combined with each other, adjacent modules are structurally and communicatively connected to each other, and the plurality of modules form a plurality of paths to transport a specimen rack which is output from one specimen output device A to the plurality of analysis devices E (E1~E7). The specimen transport system 100 shown in FIG. 1 is merely an example configuration of a combination of the plurality of modules, and alternatively, the specimen transport system 100 may be formed by a combination different from the example configuration of FIG. 1.

The straight-line module B is a module that moves the specimen rack which has been transported in from an upstream side in a straight line and transports the specimen rack out to a downstream side. For example, the straight-line module B1 moves in a straight line the specimen rack which is output from the specimen output device A and transported to the straight-line module B1, and transports the specimen rack out to the turn module C3.

The straight-line module B includes a conveyor of a straight line shape, and moves the specimen rack while placing the specimen rack on the straight-line-shaped conveyor. For example, a stopper of the specimen rack and a sensor for detecting presence/absence of the specimen rack are provided at an entrance (upstream side) of the conveyor, and a stopper and a sensor are provided, for example, also at an exit (downstream side) of the conveyor.

4

The turn module C is a module that rotationally moves the specimen rack which is transported in from the upstream side, and transports the specimen rack out to a desired downstream side corresponding to the specimen rack. For example, the turn module C3 rotationally moves a specimen rack which is transported in from the straight-line module B1 to a rotational direction (directions 1~3) corresponding to the specimen rack, and transports the specimen rack out to one of the connection module D6, the connection module D7, and the straight-line module B2.

The turn module C includes a turntable, places the specimen rack which has been transported in from the upstream side on the turn table to rotationally move the specimen rack to a direction according to the specimen rack, and transports the specimen rack out to the downstream side corresponding to one of the directions 1~3. For example, a stopper of the specimen rack and a sensor that detects presence/absence of the specimen rack are provided at an entrance (upstream side) of the turntable, and a stopper and a sensor are provided, for example, also at an exit (downstream side) of the turntable.

The connection module D is a module that transports the specimen rack which has been transported in from the upstream side out to the analysis device E at the downstream side. For example, the connection module D6 transports the specimen rack which has been transported in from the direction 2 of the turn module C3 to the analysis device E6.

FIG. 1 shows, as a representative example of the plurality of modules, the straight-line modules B, the turn modules C, and the connection modules D. Alternatively, modules other than these modules may be provided as necessary. For example, a buffer module that temporarily retracts the transported specimen rack and that changes the order of transport of the specimen rack may be provided. Alternatively, straight-line modules having different lengths from each other or turn modules having a different number of directions from each other may be provided.

Furthermore, as the branch module, in place of or in addition to the turn module, for example, a traverse transport module or an elevator transport module may be provided.

The traverse transport module is a module that slides, within a horizontal plane, the specimen rack which has been transported in from the upstream side, and transports the specimen rack out to a desired downstream side corresponding to the specimen rack. The traverse transport module slides, for example, the specimen rack which has been transported in from the upstream side in the horizontal plane in a direction perpendicular to the transported direction of the specimen rack, and transports the specimen out to the desired downstream side. On the other hand, the elevator transport module is a module that moves the specimen rack which has been transported in from the upstream side in a vertical direction (up-and-down direction), and transports the specimen rack out to the desired downstream side corresponding to the specimen rack.

Branch modules that can select a desired downstream side without rotating the specimen rack such as the traverse transport module and the elevator transport module may be used. Alternatively, a branch module may be used in which the rotation, the sliding in the horizontal plane, and the movement in the vertical direction of the specimen rack are suitably combined.

The specimen transport system 100 of FIG. 1 transports the specimen rack based on a destination code signal correlated to each specimen rack, along a path indicated by the destination code signal. When transporting the specimen rack which has been transported in from the upstream side

5

out to the downstream side, the modules of the specimen transport system **100** transmit the destination code signal correlated to the specimen rack to the downstream side along with the specimen rack. For example, the destination code signal is transmitted in parallel to the transporting of the specimen rack.

In particular, the turn module C rotates the specimen rack in one of the directions **1~3** according to the destination code signal which is transmitted along with the specimen rack, to select a downstream side corresponding to the destination code signal. The turn module C has a function which can freely set the rotational direction of the specimen rack for each code indicated by the destination code signal, according to a free combination of the plurality of modules including the turn module C. A setting of the rotational direction for the turn module C and control of the rotational direction in the turn module C will now be described.

FIG. **2** is a diagram showing a first specific example configuration of the setting and control of the turn module. FIG. **2** shows a specific example configuration of the setting of the rotational direction for three turn modules C (**C1~C3**) in the specimen transport system **100** of FIG. **1** and the control of the rotational direction in the turn modules C. The plurality of analysis devices E (**E1~E7**) in FIG. **2** also correspond to the analysis devices E in the specimen transport system **100** of FIG. **1**.

In FIG. **2**, the destination code signal is formed by 3 bits, and each code identified by the 3 bits is correlated to each of the analysis devices E. In other words, each code is correlated to the path to each analysis device E. For example, when the code is shown in the order of bit2, bit1, and bit0, a destination code signal (L, L, H) is correlated to the analysis device E1, and a destination code signal (L, H, L) is correlated to the analysis device E2.

In the first specific example configuration of FIG. **2**, a plurality of direction switches (direction SWs) are provided for the turn modules C. The direction SWs SW1~SW7 are correlated to the codes of the destination code signal. For example, SW1 is correlated to the destination code signal (L, L, H), and SW2 is correlated to the destination code signal (L, H, L).

The direction SWs SW1~SW7 are formed by setting bits of 2 bits for determining the rotational direction. The setting bits of each of the direction SWs are set, for example, according to a constructed system and by the system constructor who constructs the specimen transport system **100** (FIG. **1**) by freely combining the plurality of modules.

With the setting bits of 2 bits in each direction SW, the rotational direction of the specimen rack corresponding to the direction SW is set. In the first specific example configuration of FIG. **2**, if the setting bits of the direction SW are shown in the order of bit1, and bit0, setting bits of (OFF, ON) indicate a rotational direction of 0 degree, setting bits of (ON, OFF) indicate a rotational direction of 90 degrees to the right, and setting bits of (ON, ON) indicate a rotational direction of 90 degrees to the left.

The setting related to the direction SW of the turn module C shown in FIG. **2** corresponds to the transport paths in the specimen transport system **100** of FIG. **1**. Thus, the control of the turn module C in the first specific example configuration of FIG. **2** will be described with reference to FIG. **1**.

For example, when a specimen rack to be analyzed by the analysis device E1 is output from the specimen output device A, the straight-line module B1 correlates a destination code signal of (L, L, H) to the specimen rack, transports the specimen rack to the turn module C3, and transmits the destination code signal (L, L, H) to the turn module C3.

6

The turn module C3 uses, of the plurality of direction SWs, setting bits of (OFF, ON) of SW1 corresponding to the destination code signal (L, L, H). Thus, the rotational direction of the specimen rack is controlled to the direction **1** which is 0 degree, and the specimen rack is transported out to the straight-line module B2. The straight-line module B2 transports the specimen rack which has been transported to the turn module C2, and transmits to the turn module C2 the destination code signal (L, L, H) correlated to the specimen rack.

The turn module C2 uses, of the plurality of direction SWs, setting bits of (OFF, ON) of SW1 corresponding to the destination code signal (L, L, H). Thus, the rotational direction of the specimen rack is controlled to the direction **1** which is 0 degree, and the specimen rack is transported out to the straight-line module B3. The straight-line module B3 transports the specimen rack which has been transported to the turn module C1, and transmits to the turn module C1 the destination code signal (L, L, H) correlated to the specimen rack.

The turn module C1 uses, of the plurality of direction SWs, setting bits of (OFF, ON) of SW1 corresponding to the destination code signal (L, L, H). Thus, the rotational direction of the specimen rack is controlled to the direction **1** which is 0 degree, and the specimen rack is transported out to the connection module D1. The connection module D1 transports to the analysis device E1 the specimen rack which has been transported.

In this manner, the specimen rack is transported from the straight-line module B1 at the furthest upstream side to the connection module D1 at the furthest downstream side along the path from the specimen output device A to the analysis device E1, formed in the specimen transport system **100**.

In addition, when, for example, a specimen rack to be analyzed by the analysis device E6 is output from the specimen output device A, the straight-line module B1 correlates a destination code signal of (H, H, L) to the specimen rack, transports the specimen rack out to the turn module C3, and transmits the destination code signal (H, H, L) to the turn module C3.

The turn module C3 uses, of the plurality of direction SWs, setting bits of (ON, OFF) of SW6 corresponding to the destination code signal (H, H, L). Thus, the rotational direction of the specimen rack is controlled to the direction **2** which is 90 degrees to the right, and the specimen rack is transported out to the connection module D6. The connection module D6 transports to the analysis device E6 the specimen rack which has been transported.

In this manner, the specimen rack is transported from the straight-line module B1 at the furthest upstream side to the connection module D6 at the furthest downstream side, along a path from the specimen output device A to the analysis device E6, formed in the specimen transport system **100**. Because the turn modules C2 and C1 are not used for the path from the specimen output device A to the analysis device E6, in the turn modules C2 and C1, setting bits of SW6 corresponding to the destination code signal (H, H, L) of the analysis device E6 are set to (OFF, OFF), or to a non-set state.

Specific example configurations of the control from the specimen output device A to the analysis device E1 and to the analysis device E6 have been described. For other analysis devices E (**E2~E5**, **E7**) also, the turn modules C are controlled according to the setting related to the direction SWs of the turn modules C shown in FIG. **2**, and the specimen rack is transported from the specimen output device A to a desired analysis device E.

FIG. 3 is a diagram showing a second specific example configuration of the setting and control of the turn modules. FIG. 3 shows a specific example configuration of the setting of the rotational direction for the three turn modules C (C1~C3) in the specimen transport system 100 of FIG. 1, and the control of the rotational directions of the turn modules C. A plurality of analysis device E (E1~E7) of FIG. 3 also correspond to the analysis devices E in the specimen transport system 100 of FIG. 1.

Similar to the first specific example configuration of FIG. 2, in the second specific example configuration of FIG. 3 also, the destination code signal is formed with 3 bits, and codes identified by 3 bits are correlated to the analysis devices E. In other words, each code is correlated to the path to the corresponding analysis device E.

In the second specific example configuration of FIG. 3, dip switches (DPSW) of 3 rows from SW1 to SW3 are provided for the turn modules C. Each switch row (SW1~SW3) is formed with a dip switch of 7 bits. Each bit (bit1~bit7) of the dip switch is correlated to a respective code of the destination code signal. For example, the bit1 of the dip switch is correlated to the destination code signal (L, L, H), and the bit2 of the dip switch is correlated to the destination code signal (L, H, L).

In the second specific example configuration of FIG. 3, with a setting of the dip switches (DPSW) of 3 rows from SW1 to SW3, the rotational directions of the specimen rack at the turn modules C are determined. The dip switch (DPSW) of 3 rows is set, for example, according to a constructed system and by a system constructor who constructs the specimen transport system 100 (FIG. 1) by freely combining the plurality of modules.

In the second specific example configuration of FIG. 3, if the setting states of the dip switch are shown in the order of SW1, SW2, and SW3, a setting state of (ON, OFF, OFF) indicates a rotational direction of 0 degree, a setting state of (OFF, ON, OFF) indicates a rotational direction of 90 degrees to the right, and a setting state of (OFF, OFF, ON) indicates a rotational direction of 90 degrees to the left.

The setting related to the dip switch for the turn modules C shown in FIG. 3 also corresponds to the transport paths in the specimen transport system 100 of FIG. 1. Thus, a control of the turn modules C in the second specific example configuration of FIG. 3 will be described with reference to FIG. 1.

For example, when a specimen rack to be analyzed by the analysis device E3 is output from the specimen output device A, the straight-line module B1 correlates a destination code signal (L, H, H) to the specimen rack, transports the specimen rack out to the turn module C3, and transmits the destination code signal (L, H, H) to the turn module C3.

The turn module C3 uses, of the dip switch of 7 bits, a setting state of (ON, OFF, OFF) of the bit3 corresponding to the destination code signal (L, H, H). Thus, the rotational direction of the specimen rack is controlled to the direction 1 which is 0 degree, and the specimen rack is transported out to the straight-line module B2. The straight-line module B2 transports the specimen rack which has been transported to the turn module C2, and transmits to the turn module C2 the destination code signal (L, H, H) correlated to the specimen rack.

The turn module C2 uses, of the dip switch of the 7 bits, a setting state of (ON, OFF, OFF) of the bit3 corresponding to the destination code signal (L, H, H). Thus, the rotational direction of the specimen rack is controlled to the direction 1 which is 0 degree, and the specimen rack is transported out to the straight-line module B3. The straight-line module B3

transports the specimen rack which has been transported to the turn module C1, and transmits to the turn module C1 the destination code signal (L, H, H) correlated to the specimen rack.

The turn module C1 uses, of the dip switch of 7 bits, a setting state of (OFF, OFF, ON) of the bit3 corresponding to the destination code signal (L, H, H). Thus, the rotational direction of the specimen rack is controlled to the direction 3 which is 90 degrees to the left, and the specimen rack is transported out to the connection module D3. The connection module D3 transports the specimen rack which has been transported to the analysis device E3.

In this manner, the specimen rack is transported from the straight-line module B1 at the furthest upstream side to the connection module D3 at the furthest downstream side, along a path from the specimen output device A to the analysis device E3, formed in the specimen transport system 100.

In addition, for example, when a specimen rack to be analyzed by the analysis device E7 is output from the specimen output device A, the straight-line module B1 correlates a destination code signal of (H, H, H) to the specimen rack, transports the specimen rack out to the turn module C3, and transmits the destination code signal (H, H, H) to the turn module C3.

The turn module C3 uses, of the dip switch of the 7 bits, a setting state of (OFF, OFF, ON) of the bit7 corresponding to the destination code signal (H, H, H). Thus, the rotational direction of the specimen rack is controlled to the direction 3 which is 90 degrees to the left, and the specimen rack is transported out to the connection module D7. The connection module D7 transports to the analysis device E7 the specimen rack which has been transported.

In this manner, the specimen rack is transported from the straight-line module B1 at the furthest upstream side to the connection module D7 at the furthest downstream side along a path from the specimen output device A to the analysis device E7, formed in the specimen transport system 100. Because the turn modules C2 and C1 are not used in the path from the specimen output device A to the analysis device E7, in the turn modules C2 and C1, setting states of the bit7 corresponding to the destination code signal (H, H, H) of the analysis device E7 are set to (OFF, OFF, OFF), or to the non-set state.

Specific example configurations of the controls from the specimen output device A to the analysis device E3 and to the analysis device E7 have been described. For the other analysis devices E (E1, E2, E4~E6) also, the turn modules C are controlled according to the setting states related to the dip switch of the turn modules C shown in FIG. 3, and the specimen rack is transported from the specimen output device A to a desired analysis device E.

In the setting state of FIG. 3, when the analysis device E7 becomes non-usable due to, for example, failure or the like, the setting state of the bit7 of the dip switch of the turn module C3 may be changed from (OFF, OFF, ON) to (OFF, OFF, OFF). With such a process, in the turn module C3, the setting state of the bit7 corresponding to the destination code signal (H, H, H) of the analysis device E7 is set to (OFF, OFF, OFF) or to the non-set state, and a control is applied so that the specimen rack is not transported out to the analysis device E7. When the analysis device E7 again becomes useable, the setting state of the bit7 of the dip switch of the turn module C3 may be returned to (OFF, OFF, ON).

In this manner, the specimen rack which is output from the specimen output device A is transported to the analysis

device E corresponding to the destination code signal. Next, a structure of each module used in the specimen transport system **100** of FIG. **1** will be described.

FIG. **4** is a diagram showing a structure of each module. Each module has a connection unit for connecting another module or another device at an upstream side or a downstream side. Each module further has a rack transport unit **50** formed by, for example, a conveyer and a stopper, and transports the specimen rack which is transported from the upstream side to the downstream side.

On an entrance (upstream side) of the conveyer which moves the specimen rack with the specimen rack placed thereon, a sensor **20** which detects presence/absence of the specimen rack is provided, and, for example, a sensor **20** is also provided on an exit (downstream side) of the conveyer. For example, based on a detection result of the sensors **20**, the presence/absence of the specimen rack in each module is checked.

A controller **10** controls elements in each module. Because it is sufficient for the controller **10** to control only the elements in the module having the controller **10**, for example, the controller **10** can be realized using a micro-computer or the like of a relatively small scale, without using a CPU or the like of a relatively large scale equipped in a computer or the like.

A setting state in the module or the like is displayed on a display **30**. The display **30** may be realized by a display device such as, for example, an LCD, or may alternatively be realized by a simple structure that shows the setting state of the direction SW (FIG. **2**) or the dip switch (FIG. **3**) with an LED or the like.

An operation unit **40** accepts an operation of a user, in particular, a system constructor who constructs the specimen transport system. The operation unit **40** may be realized by a touch panel or the like along with the display **30**, or may alternatively be realized by a plurality of switches that switch ON/OFF of the direction SW (FIG. **2**) or the dip switch (FIG. **3**).

A structure common to the modules has been described. In addition, according to the type of the module, for example, for a turn module, a rack rotating unit **60** formed with a turntable or the like for rotating the specimen rack is provided; for a buffer module, a rack retraction unit **70** for temporarily retracting the specimen rack to change the order of transport of the specimen rack is provided; and for the connection module, an analysis device connection unit **80** in which an analysis device is connected at the downstream side is provided.

Moreover, each module exchanges various signals with an upstream module connected at the upstream side and a downstream module connected at the downstream side. For example, a rack request signal, a module state signal, and a node signal array are sent from the module to the upstream module, and from the downstream module to the module. In addition, the destination code signal and a rack send signal are transmitted from the upstream module to the module, and from the module to the downstream module.

FIG. **5** is a timing chart of signals exchanged between the modules when the specimen rack is transferred. In the timing chart of FIG. **5**, various signals exchanged during transfer of the specimen rack between an upstream side module and a downstream side module which are connected to each other are shown. In other words, FIG. **5** shows the destination code signal, the rack send signal, the rack request signal, and the module state signal. These signals are all set to H (OFF)

in, for example, an initialization process of the system immediately after the specimen transport system **100** (FIG. **1**) is powered on (ON).

In the transfer of the specimen rack, first, the module state signal is referred to. The module state signal is a signal which indicates whether or not the module outputting the signal is in a state where the specimen rack can be accepted. The module state signal is set, for example, to H (OFF) when the specimen rack cannot be accepted, and to L (ON) when the specimen rack can be accepted.

In the example configuration shown in FIG. **5**, the module state signal which is output from the downstream side module to the upstream side module is set to L (ON) at time T1. In other words, the example configuration shows that the downstream side module assumes a state where the module can accept the specimen rack at time T1. When the module state signal is set to L (ON), the upstream side module outputs a destination code signal correlated to the specimen rack.

The destination code signal is formed by, for example, 3 bits, and each code identified with 3 bits is correlated to the respective analysis device E (refer to FIGS. **2** and **3**). In the example configuration of FIG. **5**, the destination code signal which is output from the upstream side module to the downstream side module is set to L (ON) at time T2. In other words, at least one bit of the destination code signal formed by 3 bits is set to L (ON) at time T2.

When the destination code signal is set to L (ON), the downstream side module judges whether or not the module can accept a specimen rack corresponding to the destination code signal, and, when the module can accept the specimen rack, the rack request signal is set to L (ON). For example, the module judges whether or not the specimen rack can be accepted based on a node signal array to be described later in detail. In the example configuration of FIG. **5**, the rack request signal which is output from the downstream side module to the upstream side module is set to L (ON) at time T3.

When the upstream side module confirms that the rack request signal is set to L (ON), the upstream side module sets the rack send signal to L (ON). The rack send signal is a signal which indicates a timing of transporting out the specimen rack. In the example configuration of FIG. **5**, the rack send signal which is output from the upstream side module to the downstream side module is set to L (ON) at time T4. The upstream side module starts transporting out the specimen rack by activating the rack transport unit at time T4, and the downstream side module also starts transporting in the specimen rack by activating the rack transport unit at time T4.

In this manner, the transporting out and in of the specimen rack are started between the upstream side module and the downstream side module, and, when the transporting in of the specimen rack is completed at the downstream side module, the downstream side module completes the transport-in operation of the specimen rack, and sets the rack request signal to H (OFF). In the example configuration of FIG. **5**, the rack request signal which is output from the downstream side module to the upstream side module is set to H (OFF) at time T5.

When the upstream side module confirms that the rack request signal is set to H (OFF), the upstream side module completes the transport-out operation of the specimen rack, and sets the rack send signal to H (OFF) and all of the destination code signals to H (OFF). In the example configuration of FIG. **5**, the rack send signal and the destination

11

code signal which are output from the upstream side module to the downstream side module are set to H (OFF) at time T6.

When the downstream side module confirms that the rack send signal is set to H (OFF), the downstream side module sets the module state signal to H (OFF). In the example configuration of FIG. 5, the module state signal which is output from the downstream side module to the upstream side module is set to H (OFF) at time T7. In other words, the timing chart shows a state in which the downstream side module cannot accept a next specimen rack at the time T7 because the specimen rack is present in the downstream side module.

When the specimen rack present in the downstream side module is transported out to the module at a further downstream side, the downstream side module which has completed transporting out the specimen rack assumes a state in which the next specimen rack can be accepted from the upstream side module, and thus, the module state signal is again set to L (ON). In the example configuration of FIG. 5, the module state signal is set to L (ON) at time T1 (2), the downstream side module becomes a state where the next specimen rack can be accepted, and the next specimen rack is transferred between the upstream side and downstream side modules.

By sequentially transferring the specimen rack by the above-described exchange of the signals between the upstream side module and the downstream side module, a plurality of specimen racks are sequentially transported to the analysis devices E corresponding to the destination code signals of the specimen racks.

Next, the node signal array used in the specimen transport system 100 of FIG. 1 will be described. The plurality of modules forming the specimen transport system 100 can be freely combined with each other, adjacent modules are structurally and communicatively connected to each other, and, with such a configuration, the specimen transport system 100 of FIG. 1, for example, is constructed. That is, a plurality of paths for transporting the specimen rack, which is output from one specimen output device A, to a plurality of analysis devices E (E1~E7) are formed. For each path, a node signal indicating possibility/impossibility of transport at the path is correlated, and a node signal array is formed from a plurality of node signals for the plurality of paths.

Each module of the specimen transport system 100 transmits, under the control of the controller 10 (FIG. 4) of the module, the node signal array acquired from the downstream side to the upstream side, and changes, in the node signal array to be transmitted, the node signal of the path including the module to transport impossible when transport in that module becomes impossible. Using the node signal array, processes such as retention of the specimen rack in the specimen transport system 100 or the like are handled.

FIGS. 6~8 are diagrams for explaining the node signal array in the specimen transport system 100 of FIG. 1 and a specific example control using the node signal array. The specific example control will now be described based on FIGS. 6 and 8, and with reference to FIG. 1.

FIG. 6 is a diagram showing a specific example control when all of the modules can transport. The node signal array is made of a plurality of nodes. Each node is correlated to each of the plurality of paths in the specimen transport system 100.

In the specific example control of FIG. 6, a node 1 is correlated to a path to the analysis device E1; that is, a path from the straight-line module B1 at the furthest upstream side to the connection module D1 at the furthest downstream

12

side. A node 2 is correlated to a path to the analysis device E2; that is, a path from the straight-line module B1 at the furthest upstream side to the connection module D2 at the furthest downstream side. Similarly, nodes 3~7 are correlated to the paths to the analysis devices E3~E7, respectively. In the specific example control of FIG. 6, the node 8 is not being used.

All of the nodes from node 1 to node 8 forming the node signal array are set to OFF, for example, in a system initialization process immediately after the specimen transport system 100 is powered on (ON).

The node signal array is sequentially transmitted from the downstream side module to the upstream side module. For example, in the example configuration of FIGS. 6 and 1, the connection module D1 is a module at the furthest downstream side in the path of the node 1 corresponding to the analysis device E1, checks whether or not the analysis device E1 connected at the downstream side can accept a specimen rack, and sets the node 1 corresponding to the analysis device E1 to ON (transport possible) when the specimen rack can be accepted. In the example configuration of FIG. 6, the node 1 is set to ON (transport possible) by the connection module D1.

The connection module D2 is a module at the furthest downstream side in the path of the node 2 corresponding to the analysis device E2, checks whether or not the analysis device E2 can accept a specimen rack, and sets the node 2 corresponding to the analysis device E2 to ON (transport possible) when the specimen rack can be accepted. In the example configuration of FIG. 6, the node 2 is set to ON (transport possible) by the connection module D2.

Similarly, the connection modules D3~D7 check the states of the analysis devices E3~E7 connected thereto, and set the corresponding node to ON (transport possible) when the specimen rack can be accepted. In the example configuration of FIG. 6, all of the analysis devices E1~E7 can accept the specimen rack, and each of the connection modules D1~D7 sets the corresponding node of the node 1~the node 7 to ON (transport possible).

The node signal array is sequentially transmitted from the downstream side module to the upstream side module. For example, in the example configuration of FIGS. 6 and 1, the connection modules D1~D3 are connected to the downstream side of the turn module C1. Because of this, the node signal array is transmitted from each of the connection modules D1~D3 to the turn module C1, and the turn module C1 merges the node signal arrays acquired from the connection modules D1~D3, and transmits the node signal array to the upstream side of the turn module C1.

Specifically, in the example configuration of FIG. 6, because each of the connection modules D1~D3 sets the corresponding node of the node 1~the node 3 to ON, the turn module C1 produces a node signal array setting all nodes of the node 1 the node 3 to ON, and transmits the produced node signal array to the straight-line module B3 at the upstream side. The straight-line module B3 transmits the node signal array transmitted from the turn module C1 to the turn module C2 at the upstream side.

In the turn module C2, the connection modules D4 and D5 and the straight-line module B3 are connected at the downstream side. Because of this, node signal arrays are transmitted from the connection modules D4 and D5 and the straight-line module B3 to the turn module C2. The turn module C2 merges the node signal arrays acquired from the connection modules D4 and D5 and the straight-line module B3, and transmits the node signal array to the upstream side of the turn module C2.

13

Specifically, in the example configuration of FIG. 6, the connection modules D4 and D5 set the corresponding nodes of the node 4 and node 5 to ON, and the node 1~the node 3 are set to ON in the node signal array acquired from the straight-line module B3. Because of this, the turn module C2 produces a node signal array setting all nodes of the node 1~the node 5 to ON, and transmits the produced node signal array to the straight-line module B2 at the upstream side. The straight-line module B2 transmits the node signal array transmitted from the turn module C2 to the turn module C3 at the upstream side.

In the turn module C3, the connection modules D6 and D7 and the straight-line module B2 are connected at the downstream side. Because of this, node signal arrays are transmitted from the connection modules D6 and D7 and the straight-line module B2 to the turn module C3. The turn module C3 merges the node signal arrays acquired from the connection modules D6 and D7 and the straight-line module B2, and transmits the node signal array to the upstream side of the turn module C3.

Specifically, in the example configuration of FIG. 6, the connection modules D6 and D7 set the corresponding node of the node 6 and the node 7 to ON, and the node 1~the node 5 are set to ON in the node signal array acquired from the straight-line module B2. Because of this, the turn module C3 produces a node signal array setting all nodes of the node 1~the node 7 to ON, and transmits the produced node signal array to the straight-line module B1 at the upstream side.

The straight-line module B1 placed at the furthest upstream side requests, to the specimen output device A connected at the upstream side, a specimen rack to be transported to each path while referring to the node signal array transmitted from the downstream side. The straight-line module B1 requests a specimen rack to be transported to a path corresponding to a node which is set to ON (transport possible) in the node signal array while avoiding a request of a specimen rack to be transported to a path corresponding to a node which is set to OFF (transport impossible) in the node signal array.

Specifically, in the example configuration of FIG. 6, all paths of the node 1~the node 7 are set to ON (transport possible), and all of the analysis devices E1~E7 can accept a specimen rack. Therefore, the straight-line module B1 can request to the specimen output device A a specimen rack related to all paths of the node 1~the node 7.

FIG. 7 is a diagram showing a specific example configuration where the connection module cannot transport. FIG. 7 shows a specific example configuration where a state of transport impossibility has occurred in the connection module D3 from the state where all of the modules can transport (FIG. 6).

In the example configuration of FIG. 6 described above, the connection module D3 checks the state of the analysis device E3 connected at the downstream side, and has set the node 3 to ON (transport possible) because the analysis device E3 can accept the specimen rack.

However, when, for example, analysis is being executed in the analysis device E3 for the specimen rack which is already transported and the next specimen rack cannot be accepted, or when there is some kind of trouble in the analysis device E3 and the specimen rack cannot be accepted, as shown in FIG. 7, the connection module D3 sets the node 3 to OFF (transport impossible). When there is some kind of trouble in the connection module D3 itself and the specimen rack cannot be accepted also, the connection module D3 sets the node 3 to OFF (transport impossible).

14

When the node 3 is set to OFF in the node signal array acquired from the connection module D3, in the turn module C1 which merges the node signal arrays of the connection modules D1~D3 also, the node 3 is set to OFF, and the node signal array merged at the turn module C1 is transmitted to the turn module C2 via the straight-line module B3.

When the node 3 is set to OFF in the node signal array acquired from the straight-line module B3, in the turn module C2 which merges the node signal arrays from the straight-line module B3 and the connection modules D4 and D5 also, the node 3 is set to OFF, and a node signal array merged at the turn module C2 is transmitted to the turn module C3 via the straight-line module B2.

When the node 3 is set to OFF in the node signal array acquired from the straight-line module B2, in the turn module C3 that merges the node signal arrays from the straight-line module B2 and the connection modules D6 and D7 also, the node 3 is set to OFF, and a node signal array merged at the turn module C3 is transmitted to the straight-line module B1.

The straight-line module B1 placed at the furthest upstream side requests, to the specimen output device A which is connected at the upstream side, a specimen rack to be transported to each path while referring to the node signal array transmitted from the downstream side. The straight-line module B1 requests a specimen rack to be transported to a path corresponding to a node which is set to ON (transport possible) in the node signal array, while avoiding a request of a specimen rack to be transported to a path corresponding to a node which is set to OFF (transport impossible) in the node signal array.

In the example configuration of FIG. 7, because the path of the node 3 is set to OFF, the straight-line module B1 requests specimen racks related to paths of nodes which are set to ON, while avoiding a request of a specimen rack related to the path of the node 3. The specimen rack for which the request is avoided is temporarily put to hold, for example, in the specimen output device A. When the specimen transport system 100 is transporting a specimen rack of the node 3 at the time when the path of the node 3 is set to OFF, the specimen rack is transported to a location to which the specimen rack can be transported; for example, to the connection module D3. In other words, by configuring the system such that the specimen rack is, as much as possible, not retained at the upstream side of the specimen transport system 100, it becomes possible to secure paths to the analysis devices E1, E2, and E4~E7.

FIG. 8 is a diagram showing a specific example configuration where the turn module cannot transport. FIG. 8 shows a specific example configuration where a state of transport impossibility has occurred in the turn module C1 from the state where all of the modules can transport (FIG. 6).

In the example configuration of FIG. 6 described above, the turn module C1 has produced a node signal array in which all nodes of the node 1~the node 3 are set to ON because the connection modules D1~D3 at the downstream side have set the corresponding nodes of the node 1~the node 3 to ON.

However, when, for example, some kind of trouble has occurred in the turn module C1 and the turn module C1 assumes a state in which the specimen rack cannot be accepted, the turn module C1 sets all nodes of the paths including the turn module C1 to OFF. Specifically, as shown in FIG. 8, the turn module C1 sets all of the node 1~the node 3 corresponding to the paths to the connection modules D1~D3 (analysis devices E1~E3) in which the turn module C1 is involved to OFF (transport impossible). The node

15

signal array merged at the turn module C1 is transmitted to the turn module C2 via the straight-line module B3.

When the node 1~the node 3 in the node signal array acquired from the straight-line module B3 are set to OFF, in the turn module C2 which merges the node signal arrays from the straight-line module B3 and the connection modules D4 and D5 also, the node 1 the node 3 are set to OFF, and a node signal array merged at the turn module C2 is transmitted to the turn module C3 via the straight-line module B2.

When the node 1~the node 3 are set to OFF in the node signal array acquired from the straight-line module B2, in the turn module C3 which merges the node signal arrays from the straight-line module B2 and the connection modules D6 and D7 also, the node 1~the node 3 are set to OFF, and a node signal array merged at the turn module C3 is transmitted to the straight-line module B1.

The straight-line module B1 which is placed at the furthest upstream side requests, to the specimen output device A which is connected at the upstream side, a specimen rack to be transported to each path while referring to the node signal array transmitted from the downstream side. The straight-line module B1 requests a specimen rack to be transported to a path corresponding to a node which is set to ON in the node signal array while avoiding a request of a specimen rack to be transported to a path corresponding to a node which is set to OFF in the node signal array.

In the example configuration of FIG. 8, because the paths of the node 1~the node 3 are set to OFF, the straight-line module B1 requests a specimen rack related to a path of a node which is set to ON while avoiding a request of specimen racks related to the paths of the node 1~the node 3. The specimen rack for which the request is avoided is, for example, temporarily put to hold in the specimen output device A. When the specimen transport system 100 is transporting a specimen rack of the node 1~the node 3 at the time when the paths of the node 1~the node 3 are set to OFF, the specimen rack is transported to a location where the transport is possible; for example, to the straight-line module B3. In other words, by employing a configuration so that, as much as possible, the specimen rack is not retained in the upstream side of the specimen transport system 100, it becomes possible to secure paths to the analysis devices E4~E7.

FIG. 9 is a diagram showing a specific example configuration where the straight-line module cannot transport. FIG. 9 shows a specific example configuration where a state of transport impossibility has occurred in the straight-line module B2 from the state where all of the modules can transport (FIG. 6).

In the example configuration of FIG. 6 described above, the straight-line module B2 has acquired the node signal array setting all of the node 1~the node 5 to ON, from the turn module C2 at the downstream side.

However, when, for example, some kind of trouble occurs in the straight-line module B2 and the specimen rack cannot be accepted, the straight-line module B2 sets all nodes of the paths including the straight-line module B2 itself to OFF. Specifically, as shown in FIG. 9, the straight-line module B2 sets all of the node 1~the node 5 corresponding to the paths to the connection modules D1~D5 (analysis devices E1~E5) in which the straight-line module B2 is involved to OFF (transport impossible). The node signal array changed at the straight-line module B2 is transmitted to the turn module C3.

When the node 1~the node 5 are set to OFF in the node signal array acquired from the straight-line module B2, in the turn module C3 which merges the node signal arrays

16

from the straight-line module B2 and the connection modules D6 and D7 also, the node 1~the node 5 are set to OFF, and a node signal array merged at the turn module C3 is transmitted to the straight-line module B1.

The straight-line module B1 which is placed at the furthest upstream side requests, to the specimen output device A connected at the upstream side, a specimen rack to be transported to each path while referring to the node signal array transmitted from the downstream side. The straight-line module B1 requests a specimen rack to be transported to a path corresponding to a node which is set to ON in the node signal array while avoiding a request of a specimen rack to be transported to a path corresponding to a node which is set to OFF in the node signal array.

In the example configuration of FIG. 9, because the paths of the node 1~the node 5 are set to OFF, the straight-line module B1 requests a specimen rack related to a path of the node which is set to ON while avoiding a request of a specimen rack related to the paths of the node 1~the node 5. The specimen rack for which the request is avoided is, for example, temporarily put to a hold in the specimen output device A. When the specimen transport system 100 is transporting a specimen rack for the node 1~the node 5 at the time when the paths of the node 1~the node 5 are set to OFF, the specimen rack is transported to a location where the transport is possible, and a configuration is employed in which, as much as possible, the specimen rack is not retained at the upstream side of the specimen transport system 100.

A preferable configuration of the present invention has been described. However, the above-described embodiment is merely a simple exemplification in all points of view, and does not limit the scope of the present invention. Various modified configurations are included in the present invention within the scope and spirit of the present invention.

EXPLANATION OF REFERENCE NUMERALS

B STRAIGHT-LINE MODULE; C TURN MODULE; D CONNECTION MODULE; 100 SPECIMEN TRANSPORT SYSTEM

The invention claimed is:

1. A specimen transport system, comprising:

a plurality of modules are configured to form a plurality of paths for transporting a specimen from upstream to downstream;

a microcomputer provided in each of the plurality of modules is configured to correlate a node signal indicating possibility/impossibility of transport in each of the path and forming a node signal array made of a plurality of the node signals for the plurality of paths; and

an intermediate module among the plurality of modules is placed partway on each path,

wherein the intermediate module is configured to transport a specimen which has been transported from the upstream side to the downstream side;

the microcomputer of the intermediate module is configured to transmit the node signal array acquired from the downstream side to the upstream side; and configured to change, when the intermediate module becomes unable to transport, a node signal of a path including the intermediate module in the node signal array to be transmitted to transport impossible.

17

2. The specimen transport system according to claim 1, wherein

the plurality of modules can be freely combined with each other, and adjacent modules are connected to each other to form the plurality of paths.

3. The specimen transport system according to claim 1, wherein

the plurality of modules include a furthest upstream module placed at the furthest upstream side of each path, and

the furthest upstream module has a function to request a specimen to be transported to each path to a device connected at the upstream side.

4. The specimen transport system according to claim 3, wherein

the furthest upstream module refers to the node signal array acquired from a downstream module connected at the downstream side, and requests, to the device at the upstream side, a specimen to be transported to a path for which the node signal indicates possibility of transport while avoiding a request of a specimen to be transported to a path for which the node signal indicates impossibility of transport.

5. The specimen transport system according to claim 1, wherein

the plurality of modules include a furthest downstream module placed at a furthest downstream side of each path, and

the furthest downstream module has a function to connect an analysis device of a specimen at the downstream side.

6. The specimen transport system according to claim 5, wherein

the furthest downstream module has a function to change, when an analysis device connected at the downstream side cannot accept a specimen, a node signal of a path to the analysis device via the lowermost-stream module unable to transport.

7. The specimen transport system according to claim 1, wherein

the intermediate module includes a branch module in which a plurality of downstream modules can be connected at the downstream side, and

the branch module has a function to select a downstream module according to a specimen to be transported, from among the plurality of downstream modules connected at the downstream side.

8. The specimen transport system according to claim 7, wherein

the branch module has a function to merge node signal arrays acquired from the plurality of downstream modules connected at the downstream side, and transmit the merged node signal array to the upstream side.

9. The specimen transport system according to claim 1, wherein

the intermediate module includes a branch module in which a plurality of downstream modules can be connected at the downstream side,

the branch module has a function to merge node signal arrays acquired from a plurality of downstream modules connected at the downstream side and transmit the merged node signal array to the upstream side,

the plurality of modules include a furthest downstream module placed at a furthest downstream side of each path, and

the furthest downstream module has a function to change, when an analysis device connected at the downstream

18

side cannot accept a specimen, a node signal of a path to the analysis device via the lowermost-stream module to transport impossible.

10. The specimen transport system according to claim 1, wherein

the plurality of modules include a furthest upstream module placed at a furthest upstream side of each path,

the furthest upstream module has a function to refer to a node signal array acquired from a downstream module connected at the downstream side, and to request, to a device connected at the upstream side, a specimen to be transported to a path for which the node signal indicates possibility of transport, while avoiding requesting a specimen to be transported to a path for which the node signal indicates impossibility of transport,

the intermediate module includes a branch module in which a plurality of downstream modules can be connected at a downstream side, and

the branch module has a function to merge node signal arrays acquired from the plurality of downstream modules connected at the downstream side, and to transmit the merged node signal array to the upstream side.

11. The specimen transport system according to claim 10, wherein

the plurality of modules include a furthest downstream module placed at a furthest downstream side of each path, and

the furthest downstream module has a function to change, when an analysis device connected at the downstream side cannot accept a specimen, a node signal of a path to the analysis device via the furthest downstream module to transport impossible.

12. The specimen transport system according to claim 1, wherein

the intermediate module comprises a unit that connects another module at each of the upstream side and the downstream side, a unit that transports a specimen which has been transported from the upstream side to the downstream side, and a unit that transmits a destination signal of a specimen acquired from the upstream side to the downstream side, and

the plurality of modules can be freely combined with each other, adjacent modules are connected to each other to form the plurality of paths, and each module transports a specimen which has been transported from the upstream side to a downstream side corresponding to a destination signal of the specimen, to transport the specimen along a path corresponding to the destination signal.

13. The specimen transport system according to claim 12, wherein

the specimen is housed in a specimen rack,

the intermediate module includes a branch module in which a plurality of downstream modules can be connected at the downstream side, and

the intermediate module selects a downstream module corresponding to the destination signal correlated to the specimen rack which has been transported from the upstream side, and transports the specimen rack to the selected downstream module.

14. The specimen transport system according to claim 13, wherein

the branch module has a unit which rotates the specimen rack which has been transported from the upstream side, and selects a downstream module corresponding

19

to the destination signal by rotating the specimen rack according to the destination signal correlated to the specimen rack.

15. The specimen transport system according to claim **14**, wherein

for each of a plurality of paths formed by a free combination of the plurality of modules, a code which identifies the path is correlated, and

the branch module comprises a unit that can freely set a rotational direction of the specimen rack for each code correlated to each of the plurality of paths according to the free combination of the plurality of modules including the branch module.

* * * * *

20